$$\left(\frac{dT}{dz}\right)_1 = \frac{p_1}{p_0}\left\{\left(\frac{dT}{dz}\right)_0 + \frac{Ag}{c_p}\right\} - \frac{Ag}{c_p}.$$

The explanation of subsidence inversions is apparent from these equations.

The equation of continuity furnishes an adequate expression for the variation in dz.

GEOLOGY.—*The Cretaceous faunas in the section on Vermilion Creek, Moffat County, Colorado.*[1] JOHN B. REESIDE, JR., U. S. Geological Survey.

Some years ago the writer assisted Messrs. J. D. Sears and W. H. Bradley in studying the unusually complete stratigraphic section along Vermilion Creek, in T. 10 N., R. 101 W., Moffat County, Colorado. Mr. Sears later published[2] a description of the lithologic units together with correlations based on areal studies, on stratigraphic and lithologic considerations, and on the fossils found. The regional sequence of rocks from pre-Cambrian to Eocene is present. No detailed statement of the species of fossils observed in the section has been published, however, and it is the chief purpose of this paper to record in some detail the collections from the Cretaceous beds.

The nomenclature applied to the Cretaceous beds of Vermilion Creek is that derived from southwestern Colorado: Dakota (?) sandstone, Mancos shale, and Mesaverde group, though only part of the last is exposed, a fault having carried the higher Cretaceous rocks far below the present surface. The locality is close enough to southern Wyoming, however, to show some of the stratigraphic subdivisions generally accepted in that region. As Mr. Sears has noted in the report cited above and in a later one,[3] the Mancos shale contains at the base a thin member similar to the Aspen and Mowry shales in its peculiar lithology and its fossil content; resting upon the basal member a thin sandstone similar in lithology and fossil content to beds at some places included in the Frontier formation; and upon it a thick shale member corresponding to the Hilliard shale in position, though including in the upper part shaly marine equivalents of part of the coal-bearing rocks that farther northwest would not be included in the Hilliard shale.

[1] Received January 4, 1930. Published with the permission of the Director of the U. S. Geological Survey.

[2] J. D. SEARS. *Geology and oil and gas prospects of part of Moffat County, Colorado, and southern Sweetwater County, Wyoming.* U. S. Geol. Surv. Bull. 751: 278–281. 1924.

[3] J. D. SEARS. *Geology of the Baxter Basin gas field, Sweetwater County, Wyoming.* U. S. Geol. Surv. Bull. 781: 15–22. 1926.

In terms of the section east of the Rocky Mountains the Mancos of Vermilion Creek includes equivalents of the Graneros, Greenhorn, Carlile, Niobrara, and lower Pierre formations, the last containing representatives of the Eagle and Telegraph Creek beds. In terms of the European classification it is the Turonian, Coniacian, Santonian, and lower Campanian, possibly extending also into the upper Campanian. The part of the overlying Mesaverde group present is probably equivalent to the middle part of the Pierre or upper Campanian, though very few fossils are available as a basis for an opinion. In summary form the section of the Mancos may be interpreted as follows, the unit numbers referring to the detailed section given below:

European equivalent		*Feet.*		*Equivalent in Plains Region*	
Campanian:					
Upper(?):	No. 1, fossiliferous	100			Lower part of Pierre shale
	No. 2 (part), fossiliferous	489			
	No. 2 (part), barren	735	1324		
Lower:	No. 3, fossiliferous	140		Eagle sandstone	
	No. 4 (part), fossiliferous	200			
	No. 4 (part), barren	816	1156		
Santonian:					
Upper:	No. 4 (part), fossiliferous		886	Tel. Creek formation	
Lower:	No. 4 (part), fossiliferous	383		Niobrara formation	
	No. 5, fossiliferous	75			
	No. 6, fossiliferous	75	533		
Coniacian:	No. 7, fossiliferous	320			
	No. 8, fossiliferous	430			
	No. 9, fossiliferous	106	856		
Turonian:					
Upper:	No. 10, fossiliferous	1		Carlile shale (Frontier of authors)	
	No. 11, barren	315			
	No. 12, barren	2			
	No. 13, barren	4			
	No. 14, fossiliferous	55			
	No. 15, barren	25			
	No. 16, fossiliferous	54			
	No. 17, barren	1	457		

Lower:	No. 18, fossiliferous	34		Greenhorn-Graneros (Aspen of authors)
	No. 19, barren	3		
	No. 20, fossiliferous	118	155	
		Total	5367	

It is notable that the Turonian *Prionotropis woolgari* fauna, which should appear between that containing *Metoicoceras whitei* and that containing *Prionocyclus wyomingensis,* was not found in this section and that there is little room for it. It is possible that the sediments which represent the time of the *woolgari* fauna are very thin or lacking, though there is no particular physical evidence of a hiatus. The fauna in the lower part of the Niobrara equivalent (Coniacian), containing *Inoceramus deformis, Baculites codyensis, Phlycticrioceras oregonense,* etc., is much like that described by the writer from the lower part of the Cody shale of northern Wyoming.[4] The very large shells of *Inoceramus (Haploscapha?),* mostly represented by fragments coated with *Ostrea congesta,* are abundant in the Niobrara equivalent and extend above it into the Telegraph Creek equivalent (upper Santonian) only in a scarcer and depauperate development. In some parts of the section specimens more than four feet in maximum dimension were seen in cross section. In the upper part of the Mancos shale fossils are extremely rare and extended search yielded only a few scattered species, except in the sandstone lenses at the top of the equivalent of the Eagle sandstone (lower Campanian), where a more extensive and significant fauna occurs.

The detailed section is as follows:

CRETACEOUS BEDS ON VERMILION CREEK, MOFFAT COUNTY, COLORADO

	Feet.
Mesaverde group (part):	
Williams Fork (?) formation:	
White and gray sandstone; gray and drab shale; coal beds; upper part cut off by faulting against Wasatch formation. More than	500
Iles (?) formation:	
Massive white sandstone predominant; a little gray shale and carbonaceous shale. At 75 feet above base occur *Halymenites major* Lesquereux, *Inoceramus* sp., *Cardium* sp., *Mactra formosa* Meek and Hayden. About	1700

[4] J. B. REESIDE, JR. *Cephalopods from the lower part of the Cody shale of Oregon Basin, Wyoming.* U. S. Geol. Surv. Prof. Paper 150: 1–19. 1927.

Mancos shale:

1. Gray shale, increasingly sandy toward top..... 100
2. Gray to slate-colored shale; at top of unit and 490 feet lower are lines of rusty-brown fine-grained calcareous sandstone concretions several feet in diameter, containing fossils of Montana age. In the upper horizon were noted *Pteria nebrascana* Evans and Shumard, *Baculites* sp., *Lunatia* sp.; in the lower, *Inoceramus barabini* Morton..... 1224
3. Rusty-brown medium-grained sandstone in short lenses at four horizons, separated by gray shale; most prominent lens, 6 feet thick, at base; next, 2 feet thick, 25 feet higher; third, 1 foot thick, 88 feet above base; fourth, 8 feet thick, at top. In the highest lens occur *Inoceramus sagensis* Owen, *Ostrea* sp., *Lucina* n. sp., *Corbula* n. sp., *Teredo* sp., *Volutoderma* n. sp., *Anisomyon* aff. *A. subovatus* Meek and Hayden, *Hamites novimexicanus* Reeside, *Baculites ovatus* Say, *B. asper* Morton, *Scaphites hippocrepis* DeKay, *S. aquilaensis* Reeside, *S. stantoni* Reeside; in the next to lowest, *Inoceramus sagensis* Owen and *Haresiceras natronense* Reeside; in the lowest, *Solemya bilix* White, *Inoceramus* sp., *Ostrea* cf. *O. congesta* Conrad, *Lucina* n. sp., *Corbula* n. sp., *Ichthyodectes?* sp..... 140
4. Gray to slate-colored shale, irregular bedding; a line of gray calcareous septarian concretions at base; thin beds of soft, fine-grained gray sandstone at 647, 657, 1213, 1233, and 1269 feet above base of unit. At 2085 feet above base occur *Lucina* n. sp., *Corbula* n. sp., *Baculites* sp., *Hypsodon? radiatulus* Cockerell; at 1269 feet, *Inoceramus* sp., *Hypsodon? radiatulus* Cockerell; at 657 feet, *Desmoscaphites bassleri* Reeside and *Ichthyodectes?* sp.; at 150 feet, *Pteria gastrodes* Meek, *Inoceramus* sp., *Ostrea congesta* Conrad, *Baculites* sp., *Scaphites vermiformis* Meek and Hayden; at 45 feet, *Baculites codyensis* Reeside; at 35 feet, *Inoceramus* aff. *I. stantoni* Sokolow; at 25 feet, *Lingula* aff. *L. nitida* Meek and Hayden, *Veniella mortoni* Meek and Hayden, *Lucina subundata* Hall and Meek, *Fusus?* sp., *Baculites codyensis* Reeside, *Scaphites ventricosus* Meek and Hayden. In the lowest 400 feet fragments of a large, thick-shelled species of *Inoceramus* (*Haploscapha?*), coated with *Ostrea congesta* Conrad, are abundant; in the next overlying 800 feet they still occur but are rather rare and of smaller size..... 2285

5. Dark slate-colored shale, including five or six bands of fine-grained gray sandstone that weather to low ridges. At 25 feet above base occur *Lucina* sp., *Baculites* sp.; at 15 feet, *Ostrea congesta* Conrad and *Lucina subundata* Hall and Meek. *Inoceramus* (*Haploscapha?*) sp. and *Ostrea congesta* are abundant throughout..... 75
6. Light bluish-gray shale, laminated, breaking into flat pieces when fresh; a line of gray calcareous septarian concretions as much as 1 foot in diameter at base. At 20 feet above base occur *Lingula* aff. *L. nitida* Meek and Hayden, *Nucula* sp., *Yoldia* aff. *Y. scitula* Meek and Hayden, *Arca* n. sp., *Inoceramus* sp., *Ostrea congesta* Conrad, *Lucina subundata* Hall and Meek, *Anchura?* sp., *Anisomyon* n. sp., *Fusus* n. sp., *Baculites asper* Morton; at base, *Inoceramus umbonatus* Meek and Hayden, *Ostrea congesta* Conrad, *Baculites asper* Morton, *Ichthyodectes?* sp. *Inoceramus* (*Haploscapha?*) and *Ostrea congesta* are abundant throughout..... 75
7. Dark slate-colored shale with irregular bedding; zones of light-gray laminated shale; many thin layers of shaly sandstone that weather into papery flakes; lines of gray calcareous septarian concretions as much as 1 foot in diameter at 75 and 90 feet above base of unit; reddish sandy streaks with some reddish concretions at 125 and 190 feet above base. At 215 feet occur *Inoceramus* sp., *Ostrea congesta* Conrad, *Anisomyon* n. sp., *Baculites codyensis* Reeside; at 190 feet, *Inoceramus* aff. *I. stantoni* Sokolow; at 180 feet, *Inoceramus* aff. *I. stantoni* Sokolow, *Ostrea congesta* Conrad, *Lucina* sp., *Baculites codyensis* Reeside, *Helicoceras* aff. *H. corrugatum* Stanton, *Echidnocephalus?* sp., *Leucichthyops vagans* Cockerell (?); at 130 feet, *Inoceramus* aff. *I. stantoni* Sokolow, *I. undulatoplicatus* Roemer, *Ostrea congesta* Conrad, *Baculites codyensis* Reeside; at 125 feet, *Inoceramus* sp., *Ostrea congesta* Conrad, *Sauvagesia* cf. *S. austinensis* (Roemer), *Isurus?* sp.; at 75 feet, *Inoceramus* aff. *I. stantoni* Sokolow, *Baculites* sp., *Scaphites vermiformis* Meek and Hayden; at 55 feet, *Inoceramus* aff. *I. stantoni* Sokolow, *Ostrea congesta* Conrad, *Vanikoro?* sp., *Baculites asper* Morton, *Hypsodon?* sp.; at base, *Inoceramus aff. I. stantoni* Sokolow, *Baculites* sp. *Inoceramus* (*Haploscapha?*) sp. and *Ostrea conaesta* are abundant throughout.... 320
8. Light bluish-gray shale, laminated, breaking into flat pieces when fresh; a line of gray calcareous septarian concretions at 335 feet above base of unit. In the concretions occur *Inocera-*

mus aff. *I. stantoni* Sokolow, *Ostrea congesta* Conrad, *Lucina subundata* Hall and Meek, *Phlycticrioceras oregonense* Reeside, *Scaphites* sp.; at 325 feet, *Inoceramus deformis* Meek, *Ostrea congesta* Conrad, *Baculites asper* Morton; at 295 feet, *Inoceramus deformis* Meek, *I.* aff. *I. stantoni* Sokolow, *Pteria gastrodes* Meek, *Baculites* sp., *Phlycticrioceras oregonense* Reeside, *Helicoceras* cf. *H. corrugatum* Stanton; at 285 feet, *Cyphosoma* n. sp., *Solemya* n. sp., *Inoceramus deformis* Meek, *Inoceramus* aff. *I. stantoni* Sokolow with original color pattern preserved, *Ostrea congesta* Conrad, *Anisomyon?* n. sp., *Baculites asper* Morton, *Phlycticrioceras oregonense* Reeside, *Scaphites ventricosus* Meek and Hayden; at 240 feet, *Inoceramus deformis* Meek, *Ostrea congesta* Conrad, *Baculites* sp., *Scaphites* sp.; at 220 feet, *Inoceramus deformis* Meek, *Inoceramus* aff. *I. stantoni* Sokolow, *Ostrea congesta* Conrad, *Baculites asper* Morton. *Inoceramus* (*Haploscapha?*) sp. and *Ostrea congesta* are abundant throughout..... 430

9. Dark slate-colored shale with irregular bedding. Near top of unit occur *Nodosaria* n. sp., *Inoceramus* aff. *I. stantoni* Sokolow, *Lucina* sp., *Mactra emmonsi* Meek, *Lunatia?* sp., *Anchura* n. sp., *Cerithium?* n. sp., *Baculites* cf. *B. gracilis* Shumard, *Helicoceras* aff. *H. corrugatum* Stanton, *Placenticeras* cf. *P. pseudoplacenta* Hyatt. *Inoceramus* (*Haploscapha?*) sp. and *Ostrea congesta* Conrad are fairly abundant throughout..... 106
10. Large, dark reddish-brown sandstone concretions containing *Inoceramus fragilis* Hall and Meek, *Ostrea* sp., *Scaphites warreni* Meek and Hayden, *Prionocyclus* sp., *Corax* sp..... 1
11. Dark slate-colored shale with irregular bedding..... 315
12. White sandstone, stained somewhat brown on surface; makes a dip slope..... 2
13. Gray and brown carbonaceous shale; lens of coal as much as 18 inches thick..... 4
14. Massive fine to medium grained sandstone; upper part white, lower part buff; slightly cross-bedded; a little gray shale present. Near top of unit occur *Lingula* cf. *L. nitida* Meek and Hayden, *Solemya? obscura* Stanton(?), *Inoceramus* sp., *Mactra* sp., *Corbula kanabensis* Stanton, *Lunatia* aff. *L. concinna* Hall and Meek, *Prionocyclus* sp., *Petalolepis? fibrillatus* Cockerell(?)..... 55
15. Gray sandy shale..... 25

16. Gray fine-grained sandstone in layers 1 to 6 inches thick, and gray sandy shale, interbedded. At middle of unit occur *Inoceramus fragilis* Hall and Meek, *Ostrea* sp., *Scaphites* sp., *Prionocyclus wyomingensis* Meek; at base, *Ptychodus* sp.	54
17. Limy shale with cone-in-cone structure	1
18. Hard platy shale; bluish-white to cream-colored on weathered surface, dark brown on fresh surface. Fish scales abundant	34
19. Bentonite	3
20. Hard platy shale; bluish-white to cream-colored on weathered surface, dark brown on fresh surface. Fish scales abundant and at 75 feet above base of unit occur *Inoceramus labiatus* Schlotheim, *Metoicoceras whitei* Hyatt, *Leucichthyops vagans* Cockerell	118
Total thickness	5367

Dakota(?) sandstone:

Gray coarse-grained sandstone; gritty and conglomeratic bands	50
Gray shale and thin sandstones	15
White medium-grained sugary sandstone, friable	22
Dark-gray shale	24
Light-gray shale, greenish tint	16
White coarse-grained sugary sandstone, friable; contains many black grains	3
White and light-gray conglomeratic sandstone; many zones of small pebbles, mostly of black chert	27
Total thickness	157

Morrison formation.

PALEONTOLOGY.—*A new hypural fan from the Miocene of Maryland.*[1] WILLARD BERRY, Ohio State University (Communicated by JOHN B. REESIDE, JR.)

While collecting along the Calvert Cliffs of Maryland this past summer the writer found many fragments of fossil bone. Those worth preserving were turned over to the National Museum at Washington. However, in a chunk of material collected to show the lithology of the formation, a rather well preserved hypural fan was later found that seems worthy of record. The material was from the talus at the base of the cliffs south of Camp Roosevelt, and is probably from the Calvert formation of the Miocene.

The specimen may be described as follows:

[1] Received December 6, 1929.